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MEMORANDUM

TO: File

REF. NO.: 016816-05

FROM: Ian K. Richardson/John Buyers/ev/357

DATE: January 17, 2011

RE: **Remedial Action Cost Estimates**
North Sanitary Landfill, Dayton, Ohio

1.0 INTRODUCTION

The purpose of this memorandum is to present remedial action cost estimates for the four site-wide comprehensive remedial alternatives assembled in the Feasibility Study (FS) Report for the North Sanitary Landfill in Dayton, Ohio (CRA, 2011). As stated in Section 6.2.3.7 of "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (USEPA, October 1988), cost estimates for remedial alternatives need to consider capital costs [direct (construction) and indirect (nonconstruction and overhead)], annual operation and maintenance (O&M) costs, and the net present value (NPV) of capital and O&M costs. This memorandum also considers periodic costs (e.g., costs associated with 5-year reviews).

Consistent with USEPA (1988) and "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (USEPA, July 2000), the cost estimates presented in this memorandum are believed to provide an accuracy of +50 percent (percent) to -30 percent as cost estimates at the FS stage are considered to be "order-of-magnitude". The cost information presented in this memorandum is based on:

- CRA and VLSG experience with sites in a similar area, of a similar nature, and similar remedial actions
- Information obtained in March 2009 from a vendor (Gundle/SLT Environmental, Inc.) of manufactured capping materials including geosynthetic clay liner (GCL), flexible membrane liner (FML), and geosynthetic drainage net (GDN)
- Sanitary sewer discharge rates obtained from the City of Dayton (City, see Attachment A)

Unit costs were employed equally in costing all remedial alternatives.

This memorandum is structured as follows:

2.0 ESTIMATED CAPITAL COSTS

Estimated capital costs for addressing media are discussed in the following sections:

Section 2.1 Waste and Off Property Buried Waste Area (OPBWA) Soil
Section 2.2 NAPL
Section 2.3 Leachate
Section 2.4 Landfill Gas
Section 2.5 Groundwater

2.1 WASTE AND OPBWA SOIL

For waste and OPBWA soil, the remedial alternatives include:

- Relocation of Disposal Area 4 waste to be used as the grading fill and engineered subbase or bedding layer to produce an approximately 3 percent minimum slope over the remaining areas to be capped, with simple grading of the resulting Disposal Area 4 excavation to blend with existing surrounding areas and vegetated
- OPBWA waste and soil consolidation into Disposal Area 1
- Capping Disposal Areas 1, 2, 3, and 5 with either a solid waste (SW) cap (Alternatives 2a and 2b) or an alternate SW cap (Alternatives 3a and 3b)
- On-site stormwater management
- Re-establish road to residential properties

It is estimated that the relocation of Disposal Area 4 waste to be graded over the remaining disposal areas, and simple grading of the resulting Disposal Area 4 excavation, could be performed at a unit rate of $10/cy. Based on the estimated 153,708 cubic yards (cy) of waste and cover material in Disposal Area 4, the estimated cost of the waste relocation work is $1,537,080. Post-excavation sampling would be performed in Disposal Area 4 to confirm that any direct-contact risk had been addressed. The estimated cost of the post-excavation sampling is $25,000.

The estimated cost for OPBWA waste and soil consolidation into Disposal Area 1 is $7,650 (i.e., 765 cy x $10/cy). The estimated cost of the post-excavation sampling is $2,000.

Two cap design options have been identified for Disposal Areas 1, 2, 3, and 5, including an SW cap and an alternate SW cap (see Figure 4.2 of the FS Report). If an SW cap is selected, then an engineered subbase (minimum 12 inches) will be needed. If instead an alternate SW cap is selected, then a bedding layer (minimum 6 inches) will be needed. It was assumed that the Disposal Area 4 waste material (foundry sand) will satisfy the requirements for engineered subbase as established in OAC 3745-27-08(D)(22) and the requirements for a bedding layer. On-site screening of the Disposal Area 4 materials could be undertaken, if needed.

As shown in Table 1, the area to be capped is 3,020,874 ft^2. If an SW cap is selected and a minimum 12-inch engineered subbase is thus required, then 3,020,874 ft^3 or 111,884 cy of engineered subbase material would be needed. If instead an alternate SW cap is selected and a minimum 6-inch bedding layer is thus required, then 1,510,437 ft^3 or 55,942 cy of bedding layer material would be needed. As the estimated amount of material available in Disposal Area 4 (153,708 cy) exceeds these amounts, no imported engineered subbase or bedding layer material is expected to be needed. In order to achieve the approximate desired cap slope while also meeting minimum requirements for engineered subbase or bedding layer thickness, the Disposal Area 1, 2, 3, and 5 waste would need to be contoured for drainage and then the Disposal Area 4 material laid on top of the contoured waste.

Capital cost estimates for capping are shown in Table 1. Installed unit rates for vegetated layer ($25/cy), cap protection layer ($18/cy), and soil drainage layer ($20/cy) are based on CRA experience with previous projects. Installed unit rates for GCL ($0.65/$ft^2$), FML ($0.70/ft^2), and GDN ($0.65/$ft^2$) are based on pricing obtained from Gundle/SLT Environmental, Inc. The estimated cost to construct the SW cap is $9.8M and the estimated cost to construct the alternate SW cap is $6.6M.

Three other potential SW cap designs are possible within OAC 3745-27-08 with slope variance, by varying the type of drainage layer (GDN or soil drainage layer) and by varying the type of low permeability clay layer (recompacted clay or GCL). It is recognized that these designs are not identified in the FS Report; however, the estimated costs for these other potential designs (also shown in Table 1 for information purposes) were used as the basis for favoring the particular SW cap design identified in the FS Report. The installed unit rate for low permeability clay layer ($25/cy) is based on CRA experience with previous projects. The installed unit rate for GDN ($0.65/$ft^2$) is based on pricing obtained from Gundle/SLT Environmental, Inc. As shown in Table 1, the estimated cost for these other potential designs ranges from $11.5M to $13.7M, relative to the $9.8M estimated cost for the SW cap design identified in the FS Report.

No costs were included for excavation, treatment, or disposal of hazardous material during cap construction. No costs were included for management of isolated wetlands during cap construction.

An estimated $250,000 was included for stormwater management facilities, primarily for facilities that may be needed to direct Disposal Area 1 stormwater over to the existing borrow area.

The complete length of Valleycrest Drive is approximately 2,500 feet, of which an approximate 1,200-foot currently closed length would be re-opened to facilitate access to the five residences near the north (dead end) of Valleycrest Drive. The remedial action cost estimates are based on street standards provided by the City on September 24, 2010 for "Bituminous Street Pavement (Normally Residential Type Streets)" (see Attachment B); however, the actual design would be determined during RD. As shown below, the estimated cost to re-open Valleycrest Drive is $180,750.

	Item	*Unit*	*Estimated Quantity*	*Unit Price*	*Estimated Cost*
1.	Pavement Removal	yd^2	5,000	$5	$25,000
2.	Gravel Base	yd^3	1,400	$40	$56,000
3.	Asphalt	ton	850	$75	$63,750
4.	Curb	ft	2,400	$15	$36,000
				Total	$180,750

2.2 NAPL

An estimated $25,000 was included in all remedial alternatives to allow for installation of NAPL recovery wells and container systems at NSL-54L and NSL-55L.

2.3 LEACHATE

The FS Report presents a proposed leachate extraction system concept that includes up to approximately 35 leachate extraction wells that may be installed, including 28 dual-phase (i.e., leachate and LFG) extraction wells and seven single-phase (i.e., leachate only) extraction wells. It was assumed that the extraction wells would be connected via a leachate forcemain network over to the western side of the site. As shown below, the estimated cost to install such a system is $794,750.

	Item	*Unit*	*Estimated Quantity*	*Unit Price*	*Estimated Cost*
1.	Installation of ~35 extraction wells				
	i) Structural costs (HDPE)*	each	35	$10,850	$379,750
	ii) Mech./elect. pump costs (1 gpm)	each	35	$4,000	$140,000
2.	Installation of forcemain	feet	10,000	$22.50	$225,000
3.	Installation of electrical conduits and panels	l.s.	1	$50,000	$50,000
				Total	$794,750

* Average depth of extraction wells would be approximately 40 feet, based on maximum observed waste depth of 39 feet

Provided that a permit can be obtained from the City to discharge to the sanitary sewer, management of extracted leachate would include on-site pretreatment (if needed) and discharge to the sanitary sewer for treatment and disposal. It was assumed that leachate pretreatment (if needed) would consist of:

- An equalization tank with an aeration system
- Additional pretreatment via addition of a coagulant and polymer
- Clarifier
- Sludge holding tank and filter press
- Filter feed tank/cartridge filter/air stripper

Installation of such a pretreatment system would have an estimated equipment cost of $300,000 and an estimated installation and structure cost of $1,000,000 for an estimated total capital cost of $1,300,000. Discharge to the sanitary sewer would have an estimated capital cost of $25,000 (tie-in to sewer in the Brandt Pike right-of-way). An allowance of $10,000 has also been made for a system to monitor available sewer capacity (such that site discharges could be reduced or shut down if necessary to avoid backups in

the downstream network, as the City has stated would be required for a tie-in). Note that it may also be possible to discharge directly to the sanitary sewer without pretreatment.

2.4 LANDFILL GAS

Landfill gas (LFG) collection and flaring is included in all remedial alternatives.

The FS Report presents a proposed LFG collection system concept that includes up to approximately 28 dual-phase (i.e., leachate and LFG) extraction wells that may be installed. It was assumed that the extraction wells would be connected via a LFG header network over to the western portion of the site, and that the existing enclosed flare would be replaced with a utility flare. An allowance was also included to install a new perimeter LFG abatement system following cap installation. An allowance was also included for expansion of the existing perimeter LFG monitoring network. As shown below, the estimated cost to install such a system is $764,000.

	Item	*Unit*	*Estimated Quantity*	*Unit Price*	*Estimated Cost*
1.	Installation of 28 dual-phase extraction wells	(included in leachate system cost estimate)			
2.	Installation of header piping	feet	9,500	$22.50	$214,000
3.	Installation of new utility flare	l.s.	1	$200,000	$200,000
4.	Installation of new perimeter abatement system	l.s.	1	$300,000	$300,000
5.	Expansion of LFG monitoring network	l.s.	1	$50,000	$50,000
				Total	$764,000

No costs were included for potential future energy recovery devices, as the feasibility of operating such a system is unknown at this time.

2.5 GROUNDWATER

Two process options were identified for addressing groundwater, including monitoring (Alternatives 2a and 3a) and groundwater extraction (Alternatives 2b and 3b).

The only capital work required in relation to monitoring (all alternatives) is an estimated $150,000 to expand the groundwater monitoring network.

For alternatives 2b and 3b, the FS Report presents a proposed groundwater extraction system concept that includes up to approximately 10 extraction wells pumping at 2 to 5 gpm each, for a total pumping rate of 41 gpm. It was assumed that the extraction wells would be connected via a groundwater forcemain network over to the western portion of the site. As shown below, the estimated cost to install an extraction system is $276,000.

	Item	Unit	Estimated Quantity	Unit Price	Estimated Cost
1.	Installation of 10 extraction wells				
	i) Structural costs	each	10	$10,850	$108,500
	ii) Mech./elect. pump costs (2 to 5 gpm)	each	10	$5,000	$50,000
2.	Installation of forcemain	feet	3,000	$22.50	$67,500
3.	Installation of electrical conduits and panels	l.s.	1	$50,000	$50,000
				Total	$276,000

For the purpose of the remedial action cost estimates, it was assumed that extracted groundwater under Alternatives 2b and 3b would be combined with the extracted leachate for management in the same manner. Expansion of the leachate pretreatment system (described above in Section 2.3) to accommodate extracted groundwater would have an estimated incremental equipment cost of $150,000 and an estimated incremental installation and structure cost of $500,000 for an estimated total incremental capital cost of $650,000.

3.0 ESTIMATED ANNUAL O&M COSTS

Estimated annual O&M costs for addressing media are discussed in the following sections:

Section 3.1 Waste and OPBWA Soil
Section 3.2 NAPL
Section 3.3 Leachate
Section 3.4 Landfill Gas
Section 3.5 Groundwater

3.1 WASTE AND OPBWA SOIL

Annual O&M for the cap is estimated to cost $25,000. Annual O&M for stormwater facilities is estimated to cost $25,000. Costs for fence maintenance were not included given that a fence is not desired under future re-use scenarios.

3.2 NAPL

Annual O&M for NAPL monitoring/removal is estimated to cost $5,000.

3.3 LEACHATE

Annual O&M for the leachate extraction system is estimated to cost $50,000.

Annual O&M for the leachate pretreatment system (if needed) is estimated to cost $150,000.

Under the 2-series alternatives (employing an SW cap), operation of a leachate extraction system at approximately 31 gpm would generate approximately 180,000 ft³ of leachate per month. Based on the approximate monthly flow rate and rate schedule, monthly disposal costs are calculated as follows:

$16.39 per 1,000 ft³ for first 3,300 ft³ = $16.39 x 3,300/1,000	=	$ 54.09
$12.57 per 1,000 ft³ for next 30,000 ft³ = $12.57 x 30,000/1,000	=	$ 377.10
$11.13 per 1,000 ft³ over 33,300 ft³ = $11.13 x 146,700/1,000	=	$ 1,632.77
Total		$ 2,063.96

Under the 3-series alternatives (employing an alternate SW cap), operation of a leachate extraction system at approximately 38 gpm would generate approximately 220,000 ft³ of leachate per month. Based on the approximate monthly flow rate and rate schedule, monthly disposal costs are calculated as follows:

$16.39 per 1,000 ft³ for first 3,300 ft³ = $16.39 x 3,300/1,000	=	$ 54.09
$12.57 per 1,000 ft³ for next 30,000 ft³ = $12.57 x 30,000/1,000	=	$ 377.10
$11.13 per 1,000 ft³ over 33,300 ft³ = $11.13 x 186,700/1,000	=	$ 2,077.97
Total		$ 2,509.16

Extra strength surcharges may also apply depending on the actual leachate chemistry. It is estimated that disposal characterization monitoring would cost $5,000 annually. Thus, the total estimated annual O&M cost for leachate discharge to the sanitary sewer is:

	Disposal Cost				
Series	*Monthly*	*Annually*	*Annual Including Surcharge*	*Annual Monitoring*	*Total Annual Cost*
2-Series	$2,063.96	$24,767.52	$30,000.00	$5,000.00	$35,000.00
3-Series	$2,509.16	$30,109.92	$35,000.00	$5,000.00	$40,000.00

3.4 LANDFILL GAS

Annual O&M for the LFG collection/flaring system is estimated to cost $50,000. Annual O&M for LFG monitoring and LFG instrumentation maintenance is estimated to cost $25,000.

3.5 GROUNDWATER

It is estimated that groundwater monitoring would cost $150,000 annually (based on monitoring 40 wells two times per year). It is estimated that monitoring well maintenance would cost $10,000 annually.

Annual O&M for the groundwater extraction system (Alternatives 2b and 3b) is estimated to cost $50,000.

As stated above in Section 2.5, for the purpose of the remedial action cost estimates, it was assumed that extracted groundwater under Alternatives 2b and 3b would be combined with the extracted leachate for management in the same manner. O&M of the pretreatment system to accommodate extracted groundwater would have an estimated incremental annual O&M cost of $75,000.

Operation of a groundwater extraction system at approximately 41 gpm would generate approximately 240,000 ft³ of groundwater per month. Based on the approximate monthly flow rate and rate schedule, monthly disposal costs are calculated as follows:

$16.39 per 1,000 ft³ for first 3,300 ft³ = $16.39 x 3,300/1,000	=	$ 54.09
$12.57 per 1,000 ft³ for next 30,000 ft³ = $12.57 x 30,000/1,000	=	$ 377.10
$11.13 per 1,000 ft³ over 33,300 ft³ = $11.13 x 206,700/1,000	=	$ 2,300.57
Total		$ 2,731.76

Thus, disposal of approximately 41 gpm of groundwater to the sanitary sewer is estimated to cost $2,731.76/month or $33,000/year. Extra strength surcharges may also apply depending on the actual groundwater chemistry, thus, it was assumed that discharge to the sanitary sewer would cost $38,000 annually. It is estimated that disposal characterization monitoring would cost $5,000 annually. Thus, the total estimated annual O&M cost for discharge to sanitary sewer is $43,000.

4.0 ESTIMATED PERIODIC COSTS

Periodic costs can include construction/O&M activities (e.g., remedy failure, replacement, or decommissioning), professional/technical services (e.g., 5-year reviews), and institutional controls.

Regarding construction/O&M activities, remedy failure or replacement is not anticipated. Periodic construction activities would be limited to decommissioning of systems following remedy completion. The following estimated decommissioning costs have been included:

- Leachate extraction, pretreatment, and sanitary sewer tie-in system decommissioning (all alternatives): $150,000
- LFG collection/flaring system decommissioning (all alternatives): $100,000
- LFG monitoring network decommissioning (all alternatives): $50,000
- Groundwater extraction -system decommissioning (Alternatives 2b and 3b): $150,000
- Groundwater monitoring network decommissioning (all alternatives): $100,000
- Remedial Action Report (all alternatives): $100,000

At this time, 5-year reviews are the only anticipated professional/technical service periodic cost. An allowance of $50,000 has been included for each 5-year review.

Periodic institutional control costs are not expected above those already included in annual O&M and thus have not been included.

5.0 GROUNDWATER CONTINGENT REMEDIES

As discussed in the FS Report, if monitoring alone for groundwater is selected as part of the final remedy, then the following contingent remedies could potentially be relied upon if the selected remedy is determined to be not fully working as planned:

- Enhanced biodegradation
- Groundwater extraction

It is estimated that enhanced biodegradation (e.g., the addition of oxygen, chemical nutrients, or other substances to the groundwater to accelerate biodegradation) would cost $500,000.

It is estimated that groundwater extraction (e.g., a system potentially similar to that described above in Section 2.5) would cost $1,500,000.

6.0 SUMMARY

Table 2 presents a summary of estimated capital, annual O&M, and periodic costs associated with each of the four site-wide comprehensive remedial alternatives. For each medium, the complete list of remedial process options being considered are identified.

As stated in USEPA (2000), contingency is typically added as a percentage to each of the total cost of construction activities and O&M. Calculations in Table 2 include a total contingency value (scope + bid) for capital costs in the amount of 30 percent and include a total contingency value (scope + bid) for O&M costs in the amount of 30 percent. These values are within the ranges outlined in Section 5.4 of USEPA (2000).

As stated in USEPA (2000), professional/technical services are typically estimated as a percentage of each of the total cost of construction activities and O&M plus contingency. Consistent with Exhibit 5-8 of USEPA (2000), and given that the capital cost associated with all remedial alternatives is expected to exceed $10M, the following percentages were used in Table 2: Project Management (5 percent applied to both capital and O&M costs), Remedial Design (6 percent applied to capital costs), and Construction Management (6 percent applied to capital costs). Consistent with Section 5.5 of USEPA (2000), O&M technical support was assumed to be 15 percent of the total annual O&M cost.

As recommended in Section 5.6 of USEPA (2000), allowances were included in Table 2 without contingency for institutional controls such as the Environmental Covenant, groundwater-use restrictions, and site information database ($25,000 capital cost allowance, and $10,000 annual O&M allowance).

The following total periodic costs are expected (see Table 2):

- $520,000 ($400,000 plus 30 percent contingency) is expected to be incurred for decommissioning of systems associated with Alternatives 2a and 3a
- $715,000 ($550,000 plus 30 percent contingency) is expected to be incurred for decommissioning of systems associated with Alternatives 2b and 3b
- $65,000 ($50,000 plus 30 percent contingency) is expected to be incurred in association with each 5-year review for all alternatives

- $130,000 ($100,000 plus 30 percent contingency) is expected to be incurred in association with the Remedial Action Report for all alternatives

NPV calculations for O&M were based on an assumed 30-year timeframe for all remedial components. Periodic costs associated with 5-year reviews would be incurred during years 5, 10, 15, 20, and 25. Periodic costs associated with decommissioning of systems and the Remedial Action Report would be incurred in Year 30.

Consistent with USEPA (2000), NPV calculations were based on a discount rate of 7 percent. Annual and multi-year discount factors are shown in Table 3. NPVs are calculated in Table 4.

The NPV of the four site-wide remedial alternatives are as follows [for simplicity, the constants (i.e., included as part of each alternative) are not included in the descriptions below, but their estimated costs are included]:

	2a SW Cap GW Monitoring	*2b SW Cap GW Extraction*	*3a Alt. SW Cap GW Monitoring*	*3b Alt. SW Cap GW Extraction*
Capital Cost	$22,705,311	$24,113,757	$17,846,790	$19,255,236
NPV O&M Costs	$10,287,095	$13,539,257	$10,383,886	$13,636,047
NPV Periodic Costs	$217,108	$242,725	$217,108	$242,725
Total Cost	**$33,209,514**	**$37,895,738**	**$28,447,784**	**$33,134,008**

In the unlikely event that a permit cannot be obtained from the City to discharge extracted leachate and groundwater (pretreated if necessary) to the sanitary sewer, then contingent disposal options may include on-site pretreatment and discharge to an on-site infiltration impoundment or infiltration gallery (with agency approval), or transportation to an off-site commercial facility for treatment and disposal, etc. If on-site management through an infiltration impoundment/gallery is used, then the pretreated liquids would be piped to the borrow area for infiltration, as it is expected that this area will have the capacity to receive the liquids without having an appreciable negative influence on the performance of the extraction systems (the volume to be infiltrated would be less than half of the annual precipitation falling on the site). It was assumed that all of the liquids would require pretreatment and discharge characterization monitoring, and that the cost for on-site management would be the same regardless of which infiltration technology (impoundment or gallery) is used. If transportation and disposal (T&D) to an off-site commercial facility is used, then a storage tank would need to be installed to accommodate extracted liquids pending transportation (a larger tank would be needed for the b-series alternatives). In order to evaluate costs associated with T&D to an off-site commercial facility, information was obtained from a local vendor for T&D to a facility in Middletown, OH, which is located approximately 30 miles south of the site. Based on 5,000-gallon loads as indicated by the vendor, the price for transportation would be $0.057/gallon and the price for disposal would be $0.045/gallon, for a total T&D cost of $0.10/gallon. The total NPV for each alternative under both of these contingent disposal options, as well as the number of loads to be transported off site each day under the off-site T&D option (based on 5 days per week) is as follows:

Alternative	*On-Site Management NPV*	*Off-Site T&D*	
		Loads/Day	*NPV*
2a	$32,822,352	12.5	$59,215,105
2b	$37,063,340	29.0	$102,458,431
3a	$28,021,905	15.4	$61,478,816
3b	$32,262,893	31.9	$104,722,141

7.0 REFERENCES

Conestoga-Rovers & Associates, January 2011. Feasibility Study Report for the North Sanitary Landfill, Dayton, Ohio

United States Environmental Protection Agency, October 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final (EPA/540/G-89/004)

United States Environmental Protection Agency, July 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study (EPA 540-R-00-002)

TABLE 1

CAPPING CAPITAL COST ESTIMATE
NORTH SANITARY LANDFILL
DAYTON, OHIO

				Disposal Area					
				1	*2*	*5*	*3*	*Totals*	*$/acre*
			Area (ft^2):	*1,328,980*	*214,023*	*1,011,509*	*466,362*	*3,020,874*	
			Area (acres):	*30.5*	*4.9*	*23.2*	*10.7*	*69.35*	
Item	*Unit*	*Unit Price*	*Quantity (inches)*						
SW Cap									
Vegetated Layer	cy	$25	6	$615,269	$99,085	$468,291	$215,908	$1,398,553	
Cap Protection Layer	cy	$18	6	$442,993	$71,341	$337,170	$155,454	$1,006,958	
Soil Drainage Layer	cy	$20	18	$1,476,644	$237,803	$1,123,899	$518,180	$3,356,527	
FML	ft^2	$0.70		$930,286	$149,816	$708,056	$326,453	$2,114,612	
GCL	ft^2	$0.65		$863,837	$139,115	$657,481	$303,135	$1,963,568	
							Total:	$9,840,217	$141,899
Alternate SW Cap									
Vegetated Layer	cy	$25	6	$615,269	$99,085	$468,291	$215,908	$1,398,553	
Cap Protection Layer	cy	$18	12	$885,987	$142,682	$674,339	$310,908	$2,013,916	
Soil Drainage Layer	cy	$20	6	$492,215	$79,268	$374,633	$172,727	$1,118,842	
FML	ft^2	$0.70		$930,286	$149,816	$708,056	$326,453	$2,114,612	
							Total:	$6,645,923	$95,836
Other Potential SW Cap Designs[1]									
Low Permeability Clay Instead of GCL, GDN Instead of Soil Drainage Layer									
Vegetated Layer	cy	$25	6	$615,269	$99,085	$468,291	$215,908	$1,398,553	
Cap Protection Layer	cy	$18	24	$1,771,973	$285,364	$1,348,679	$621,816	$4,027,832	
GDN	ft^2	$0.65		$863,837	$139,115	$657,481	$303,135	$1,963,568	
FML	ft^2	$0.70		$930,286	$149,816	$708,056	$326,453	$2,114,612	
Low Permeability Clay Layer	cy	$25	18	$1,845,806	$297,254	$1,404,874	$647,725	$4,195,658	
							Total:	$13,700,223	$197,562
Low Permeability Clay Instead of GCL, Soil Drainage Layer Instead of GDN									
Vegetated Layer	cy	$25	6	$615,269	$99,085	$468,291	$215,908	$1,398,553	
Cap Protection Layer	cy	$18	6	$442,993	$71,341	$337,170	$155,454	$1,006,958	
Soil Drainage Layer	cy	$20	18	$1,476,644	$237,803	$1,123,899	$518,180	$3,356,527	
FML	ft^2	$0.70		$930,286	$149,816	$708,056	$326,453	$2,114,612	
Low Permeability Clay Layer	cy	$25	18	$1,845,806	$297,254	$1,404,874	$647,725	$4,195,658	
							Total:	$12,072,308	$174,087
GCL Instead of Low Permeability Clay, GDN Instead of Soil Drainage Layer									
Vegetated Layer	cy	$25	6	$615,269	$99,085	$468,291	$215,908	$1,398,553	
Cap Protection Layer	cy	$18	24	$1,771,973	$285,364	$1,348,679	$621,816	$4,027,832	
GDN	ft^2	$0.65		$863,837	$139,115	$657,481	$303,135	$1,963,568	
FML	ft^2	$0.70		$930,286	$149,816	$708,056	$326,453	$2,114,612	
GCL	ft^2	$0.65		$863,837	$139,115	$657,481	$303,135	$1,963,568	
							Total:	$11,468,133	$165,374

Notes:

GDN = geosynthetic drainage net; FML = flexible membrane liner; GCL = geosynthetic clay layer.

Quantities are based on a flat projection; therefore, there will be minor discrepancies in the volume calculations.

It is estimated that the relocation of Disposal Area 4 waste to be graded over the remaining disposal areas, and simple grading of the resulting Disposal Area 4 excavation, could be performed at a unit rate of $10/cy. Based on the estimated 153,708 cubic yards (cy) of waste and cover material in Disposal Area 4, the estimated cost of the waste relocation work is $1,537,080. Post-excavation sampling would be performed in Disposal Area 4 to confirm that any direct-contact risk had been addressed. The estimated cost of the post-excavation sampling is $25,000.

The estimated cost for OPBWA waste and soil consolidation into Disposal Area 1 is $7,650 (i.e., 765 cy x $10/cy).

[1]These represent other SW cap designs possible within OAC 3745-27-08 with slope variance.

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TABLE 2

SUMMARY OF ESTIMATED CAPITAL, ANNUAL O/M, AND PERIODIC COSTS
(LEACHATE/GROUNDWATER SANITARY SEWER DISPOSAL SCENARIO)
NORTH SANITARY LANDFILL
DAYTON, OHIO

	Alternative No.:	2a	2b	3a	3b
	Disposal Area 1, 2, 3, 5 Cap:	SW Cap	SW Cap	Alternate SW Cap	Alternate SW Cap
	Groundwater:	Monitoring	Extraction	Monitoring	Extraction
Environmental Media	Process Options				
CAPITAL COSTS					
Waste and Soil	Disposal Area 4 Waste Relocation	$1,537,080	$1,537,080	$1,537,080	$1,537,080
	Disposal Area 4 Post-Excavation Sampling	$25,000	$25,000	$25,000	$25,000
	OPBWA Waste and Soil Consolidation	$7,650	$7,650	$7,650	$7,650
	OPBWA Post-Excavation Sampling	$2,000	$2,000	$2,000	$2,000
	Cap Disposal Areas 1, 2, 3, 5	$9,840,217	$9,840,217	$6,645,923	$6,645,923
	Stormwater Management Facilities	$250,000	$250,000	$250,000	$250,000
	Valleycrest Drive Re-Opening	$180,750	$180,750	$180,750	$180,750
NAPL	Recovery Systems at NSL-54L and NSL-55L	$25,000	$25,000	$25,000	$25,000
Leachate	Extraction System	$794,750	$794,750	$794,750	$794,750
	Pretreatment System	$1,300,000	$1,300,000	$1,300,000	$1,300,000
	Sanitary Sewer Tie-In and Capacity Sensor	$35,000	$35,000	$35,000	$35,000
Landfill Gas	Collection and Monitoring System	$764,000	$764,000	$764,000	$764,000
	Energy Recovery Devices	not included	not included	not included	not included
Groundwater	Monitoring Network Expansion	$150,000	$150,000	$150,000	$150,000
	Extraction System	not included	$276,000	not included	$276,000
	Pretreatment System (incremental to leachate)	not included	$650,000	not included	$650,000
	Subtotal Capital Cost:	$14,911,447	$15,837,447	$11,717,153	$12,643,153
	Contingency (30%):	$4,473,434	$4,751,234	$3,515,146	$3,792,946
	Subtotal:	$19,384,881	$20,588,681	$15,232,299	$16,436,099
	Professional/Technical Services - Project Management (5%):	$969,244	$1,029,434	$761,615	$821,805
	Professional, Technical Services - Remedial Design (6%):	$1,163,093	$1,235,321	$913,938	$986,166
	Professional/Technical Services - Construction Management (6%):	$1,163,093	$1,235,321	$913,938	$986,166
	Institutional Controls:	$25,000	$25,000	$25,000	$25,000
	Total Capital Cost:	**$22,705,311**	**$24,113,757**	**$17,846,790**	**$19,255,236**
ANNUAL O&M COSTS					
Waste	Cap	$25,000	$25,000	$25,000	$25,000
	Stormwater Management Facilities	$25,000	$25,000	$25,000	$25,000
NAPL	Monitoring/Removal	$5,000	$5,000	$5,000	$5,000
Leachate	Extraction System	$50,000	$50,000	$50,000	$50,000
	Pretreatment System	$150,000	$150,000	$150,000	$150,000
	Off-Site Disposal	$35,000	$35,000	$40,000	$40,000
Landfill Gas	Collection and Flaring	$50,000	$50,000	$50,000	$50,000
	Monitoring	$25,000	$25,000	$25,000	$25,000
Groundwater	Extraction System	not included	$50,000	not included	$50,000
	Pretreatment System (incremental to leachate)	not included	$75,000	not included	$75,000
	Off-Site Disposal	not included	$43,000	not included	$43,000
	Monitoring	$150,000	$150,000	$150,000	$150,000
	Monitoring Well Maintenance	$10,000	$10,000	$10,000	$10,000
	Subtotal Annual O&M Cost:	$525,000	$693,000	$530,000	$698,000
	Contingency (30%):	$157,500	$207,900	$159,000	$209,400
	Subtotal:	$682,500	$900,900	$689,000	$907,400
	Professional/Technical Services - Project Management (5%):	$34,125	$45,045	$34,450	$45,370
	Professional/Technical Services - O&M Technical Support (15%):	$102,375	$135,135	$103,350	$136,110
	Institutional Controls:	$10,000	$10,000	$10,000	$10,000
	Total Annual O&M Cost:	**$829,000**	**$1,091,080**	**$836,800**	**$1,098,880**
PERIODIC COSTS [1]					
Leachate	Extraction/Pretreatment System Decommissioning	$150,000	$150,000	$150,000	$150,000
Landfill Gas	Collection System Decommissioning	$100,000	$100,000	$100,000	$100,000
	Monitoring Network Decommissioning	$50,000	$50,000	$50,000	$50,000
Groundwater	Extraction System Decommissioning	not included	$150,000	not included	$150,000
	Monitoring Network Decommissioning	$100,000	$100,000	$100,000	$100,000
	Subtotal Decommissioning Cost	$400,000	$550,000	$400,000	$550,000
	Contingency (30%):	$120,000	$165,000	$120,000	$165,000
	Subtotal:	$520,000	$715,000	$520,000	$715,000
Various	5-Year Reviews	$65,000	$65,000	$65,000	$65,000
Various	Remedial Action Report	$130,000	$130,000	$130,000	$130,000

Notes

[1] Decommissioning and Remedial Action Report costs occur at Year 30. 5-Year review costs occur at Years 5, 10, 15, 20, and 25. Includes 30% contingency.

TABLE 3

ANNUAL AND MULTI-YEAR DISCOUNT FACTORS (7%)
NORTH SANITARY LANDFILL
DAYTON, OHIO

Years	*Annual Discount Factor*	*Multi-Year Discount Factor*
1	0.935	0.935
2	0.873	1.808
3	0.816	2.624
4	0.763	3.387
5	0.713	4.100
6	0.666	4.767
7	0.623	5.389
8	0.582	5.971
9	0.544	6.515
10	0.508	7.024
11	0.475	7.499
12	0.444	7.943
13	0.415	8.358
14	0.388	8.745
15	0.362	9.108
16	0.339	9.447
17	0.317	9.763
18	0.296	10.059
19	0.277	10.336
20	0.258	10.594
21	0.242	10.836
22	0.226	11.061
23	0.211	11.272
24	0.197	11.469
25	0.184	11.654
26	0.172	11.826
27	0.161	11.987
28	0.150	12.137
29	0.141	12.278
30	0.131	12.409